Airport Capacity Enhancement

Tactical Initiative

Los Angeles International Airport

TBIT West Side Gates Expansion Study

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TBIT
(Tom Bradley International Terminal) West Side Gates Expansion Study

September 1993

Prepared jointly by the U.S. Department of Transportation, Federal Aviation Administration, the City of Los Angeles Department of Airports, and the airlines serving Los Angeles.

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Figure 1. **Los Angeles International Airport**

Figure 2. **Detail of Tom Bradley International Terminal (TBIT)**

Figure 1. Los Angeles International Airport

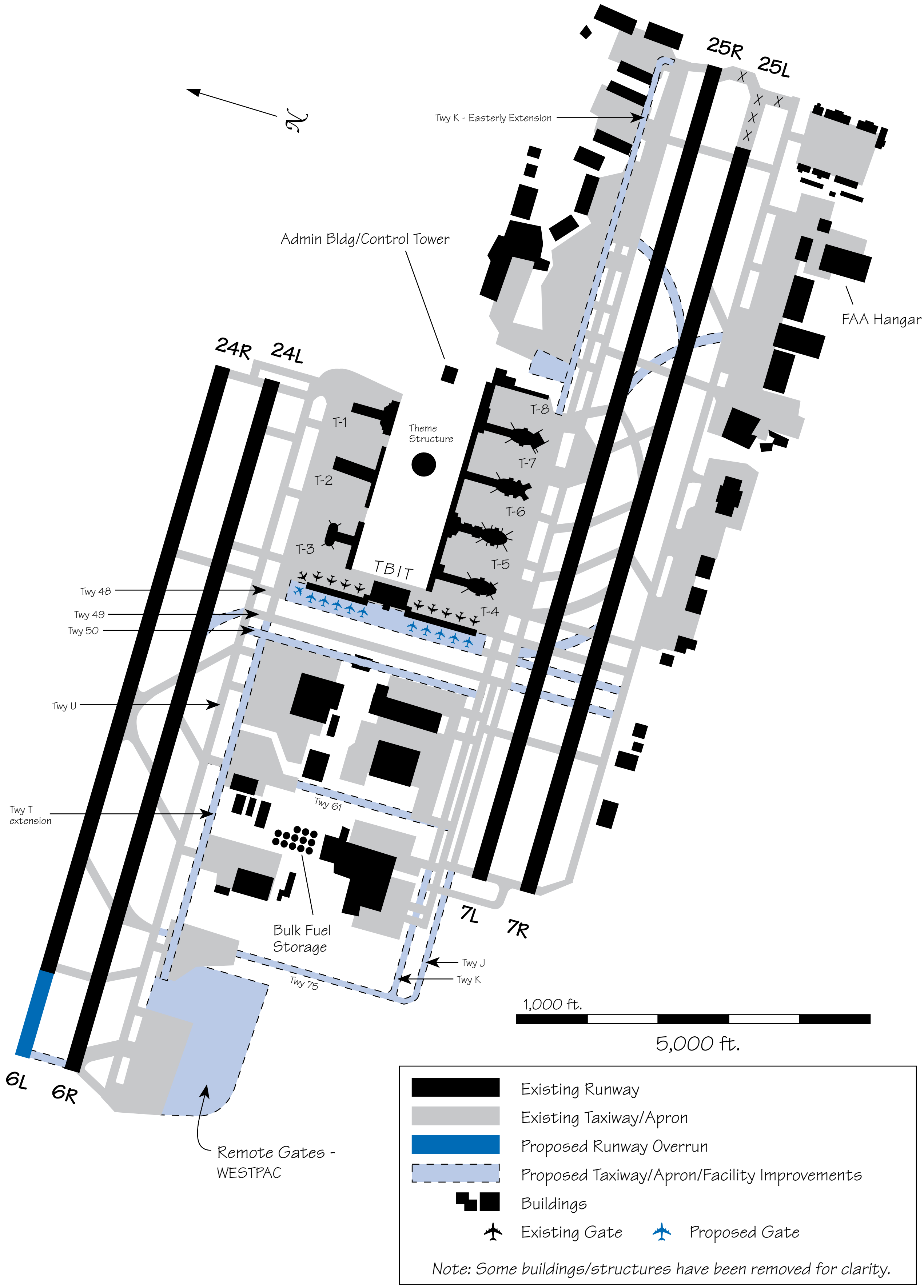
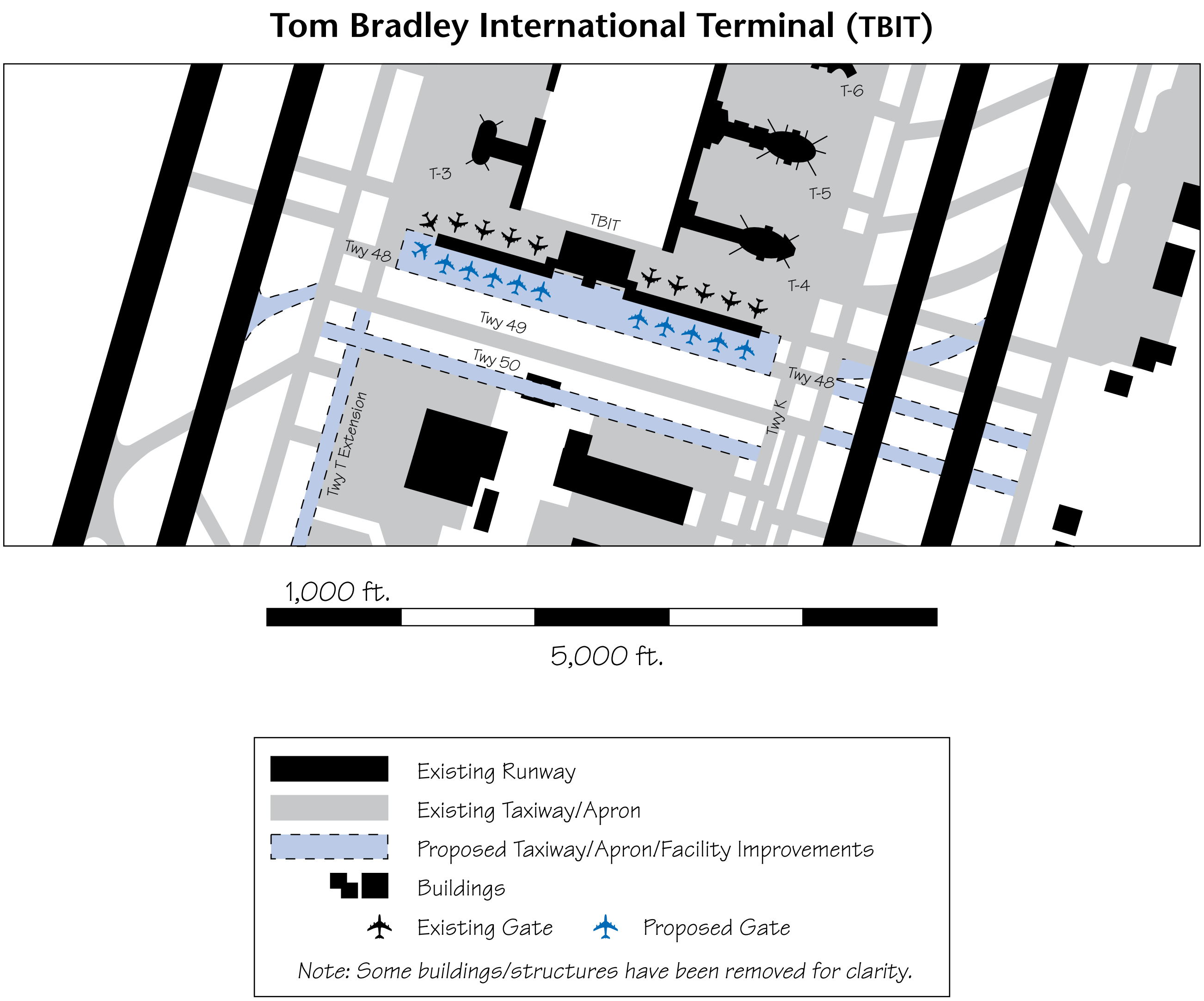


Figure 2. Detail of Tom Bradley International Terminal (TBIT) — Apron, Taxiways, and Surrounding Airfield



Introduction

Objective

This study was initiated by the Los Angeles Department of Airports and the Federal Aviation Administration (FAA) to evaluate the impact on airfield operations of adding 11 new international gates to the west side of Tom Bradley International Terminal (TBIT) at Los Angeles International Airport (LAX).

The study examined airport delays and their causes with and without the west side expansion of TBIT. Since this expansion would affect the use of the airport's existing cross-complex taxiway system, Taxiways 48 and 49, the study also examined the impact of adding additional cross-complex taxiways to mitigate the delays caused by the expansion.

Background

Since 1985, the FAA has sponsored Airport Capacity Design Teams at airports across the country affected by delay. Representatives from airport operators, air carriers, other airport users, and aviation industry groups work together with FAA representatives to identify and analyze capacity problems at each individual airport and recommend improvements that have the potential for reducing delays. The improvements recommended by the Capacity Teams have emphasized construction of new runways and taxiways, installation of enhanced facilities and equipment, and changes in air traffic control procedures. Typically, these solutions are addressed through established, *long-term* planning processes.

The FAA's Office of System Capacity and Requirements (ASC) has undertaken a series of initiatives to identify, evaluate, and implement capacity improvements that are achievable in the *near term* and will provide more immediate relief for chronic delay-problem airports. Airport Capacity Enhancement (ACE) Action Teams will be established at selected airports, again made up of representatives from airport operators, air carriers, other airport users, FAA, and aviation industry groups, to assess these near-term, tactical initiatives and guide them through implementation.

An Airport Capacity Design Team Study at Los Angeles International Airport was completed in 1991 with the publication of an Airport Capacity Enhancement Plan in September of that year. The plan recommended departure pads (staging areas) at the ends of all the runways, several terminal expansion options, various taxiway improvements, and a restructuring of Los Angeles Basin and terminal airspace. The construction of 11 additional gates on the west side of the Tom Bradley International Terminal (see Figures 1 and 2) to accommodate the anticipated increase in international traffic at LAX was recommended for further study. The Capacity Team recognized that the functions of north/south Taxiways 48 and 49 would have to be moved to the west to make room for expansion of the terminal.

International passenger traffic at LAX is forecast to grow by 67 percent by the year 2000. International arrivals at TBIT, the primary international terminal at LAX, now exceed gate capacity, and there is increasing reliance on remote gates to serve international flights. Although the original terminal plan anticipated this, and airport bus operations are well accommodated in the terminal design, the airlines and the airport would prefer to avoid the costs, lessened level of service, and delays of remote operations, if feasible. The international airlines have, therefore, requested that the airport study the possibility of adding aircraft gates for commercial operations to the west side of TBIT to supplement the gates already on the east side.

Taxiways 48 and 49, the high-speed dual taxiway system immediately adjacent to the west side of TBIT, allow aircraft to cross rapidly between the north and south runway complexes. The addition of gates on the west side of the terminal and the need for adequate space to push aircraft back from these new gates would impact these taxiways and, therefore, affect the overall flow of aircraft on the airfield.

Scope

The Capacity Team limited its analysis to aircraft activity within the terminal area airspace and on the airfield. They considered the technical and operational feasibility of the proposed airfield improvements, but did not address environmental and design issues or the cost of development and construction. These issues need to be addressed in future airport planning studies, and the data generated in this study can be used in these follow-on studies.

Methodology

The ACE Action Team, which included representatives from the FAA, the City of Los Angeles Department of Airports, and various aviation industry groups (see Appendix A), met regularly for review and coordination. The ACE Action Team considered various operational and airfield facility development options proposed by the members of the team. Alternatives that were considered practicable were developed into experiments that could be tested by simulation modeling. The FAA Technical Center's Aviation Capacity Branch provided expertise in airport simulation modeling. The ACE Action Team validated the data used as input for the simulation modeling and analysis and reviewed the interpretation of the simulation results. The data, assumptions, alternatives, and experiments were continually reevaluated, and modified where necessary, as the study progressed. Data input and assumptions can be found in Appendix B.

Initial work consisted of gathering data and formulating assumptions required for the capacity and delay analysis and modeling. Where possible, assumptions were based on actual field observations at LAX. Data generated by the Airport Capacity Design Team Study was used whenever possible. Improvements proposed by the ACE Action Team were analyzed in relation to current and future demands with the help of a computer model, the Airport Machine. Appendix C briefly explains the model.

Capacity Enhancement Alternatives

Figure 1 shows the current layout of the airport, and Figure 2 provides a more detailed look at the airfield in the vicinity of TBIT. In studying the impact of the additional gates proposed for the west side of TBIT, the Airport Capacity Enhancement (ACE) Action Team evaluated the following airfield configurations. Cost information for aircraft delay was obtained from the latest version of the AVMARK Incorporated *Quarterly Aircraft Operating Costs and Statistics*. The weighted-average aircraft direct operating cost at Los Angeles International Airport was calculated to be $1,923.11 per hour.

1. "Do Nothing" configuration.

For the baseline or present demand level, the Do Nothing configuration represents today's airfield, with no physical changes and operating under the 1992 flight schedule. For the future demand level, the Do Nothing alternative represents the future airfield with Taxiway 75 and Taxiway K East completed and 15 additional remote gates available west of Taxiway 75.

2. TBIT West — expand TBIT with 11 new gates on the west side of the terminal.

The addition of 11 new gates at TBIT would help LAX accommodate the 67 percent growth in international passenger traffic projected by the year 2000. International arrivals already exceed the gate capacity at TBIT, and the use of the WESTPAC remote gates to serve international flights would result in increased operating costs, a lessened level of service, and additional delays for the passenger.

The construction of these new gates on the west side of TBIT would significantly affect Taxiways 48 and 49, the existing high-speed dual taxiway system adjacent to the west side of the terminal. Taxiway 48 would be eliminated near the terminal and become part of the ramp area. Taxiway 49 would be reduced to operating as a taxilane because of the need to push aircraft back from the new gates, and this would result in reduced average taxiing speeds for aircraft. The loss of this high-speed cross-complex dual taxiway system would restrict the ability of aircraft to cross rapidly between the north and south runway complexes and restrict the overall flow of aircraft on the airfield.

Expanding TBIT by adding 11 gates on the west side would result in a delay-cost penalty (relative to the Do Nothing alternative) of 12,811 hours or $24.637 million per year at the present level of activity and 12,061 hours or $23.195 million per year at the future level.

The delay-cost penalty in this and the other alternatives addressed in the study represents the additional delay costs that would result from the construction of the new gates at TBIT. The delay-cost penalty is the difference between the cost of aircraft delays under the Do Nothing alternative and the cost of delays under each of the other alternatives. Future numbers in this alternative are not significantly greater than present because the future airport includes 15 additional remote gates west of Taxiway 75 for both international and domestic use, a new north/south taxiway (Taxiway 75), and a new east/west taxiway (Taxiway K).

3. TBIT West plus Taxiway 50 — expand TBIT and add one new high-speed Taxiway 50.

Construction of a new high-speed cross-complex Taxiway 50 to the west of Taxiway 49 would improve the ability of aircraft to cross rapidly between the north and south runway complexes and improve the flow of ground traffic on the airfield.

Adding one new, high-speed, north/south taxiway, Taxiway 50, in addition to expanding TBIT would result in an annual delay-cost penalty (relative to the Do Nothing alternative) of 3,339 hours or $6.422 million at the present level of activity and 5,928 hours or $11.401 million at the future level.

4. TBIT West plus Taxiways 50 and 61 — expand TBIT and add two new high-speed Taxiways 50 and 61.

Construction of two new high-speed cross-complex taxiways would further improve the ability of aircraft to cross rapidly between the north and south runway complexes and improve the flow of ground traffic throughout the airfield. Taxiway 50 would be located immediately to the west of Taxiway 49. Taxiway 61 would be constructed to join the existing Taxiway 61 on the north side of the airfield to Taxiway 60 on the south side of the airfield.

Adding two new, high-speed, north/south taxiways, Taxiways 50 and 61, in addition to expanding TBIT would result in an annual delay-cost penalty (relative to the Do Nothing alternative) of 1,066 hours or $2.05 million at the present level of activity and an annual delay-cost savings (relative to the Do Nothing alternative) of 107 hours or $0.205 million at the future level.

5. Extend Taxiway T from Taxiway 49 westerly.

Although not directly related to the TBIT west expansion, an extension of Taxiway T from Taxiway 49 to the west was examined. This alternative would provide an additional full-length parallel taxiway on the north side of the airfield. It would allow two-way traffic for arriving and departing aircraft to taxi to and from the northwest side of the airport. This evaluation assumed that Taxiway K was extended to the east and that the TBIT west expansion was not included.

Extending Taxiway T would result in no annual delay-cost penalty (relative to the Do Nothing alternative) at the present level of activity and an annual delay-cost savings (relative to the Do Nothing alternative) of 1,427 hours or $2.744 million at the future activity level. This alternative does not provide a benefit in the present case because there is not a great deal of two-way traffic bound for Taxiway T west. In the future case, the demand increases, and there are 15 additional remote gates west of Taxiway 75 for use by both international and domestic aircraft.

Although these preliminary results are promising, additional study is needed to determine conclusively the airfield benefits of this project in all circumstances.

Summary

Figure 3 provides a summary of the annual delay costs for the various alternatives in hours and millions of dollars. Note that the delay cost numbers given in the above discussion of the individual alternatives represent the alternative costs less the Do Nothing costs.

Figure 3. Summary of Alternatives and Annual Delay Cost

Alternatives	Estimated Annual Delay (hours/millions of 1993 dollars) Present Demand	Future Demand
1. Do Nothing	73,024/$140.43	108,328/$208.33
2. Expand TBIT with 11 new gates on west side of terminal	85,835/$165.07	120,389/$231.52
3. Expand TBIT and add high-speed Taxiway 50	76,363/$146.85	114,256/$219.73
4. Expand TBIT and add high-speed Taxiways 50 and 61	74,090/$142.48	108,221/$208.12
5. Extend Taxiway T from Taxiway 49 westerly*	73,024/$140.43	106,901/$205.58

* Note: This alternative does not include any of the TBIT West expansion. Conversely, none of the TBIT West alternatives include the development of Taxiway T to the west.

Conclusions

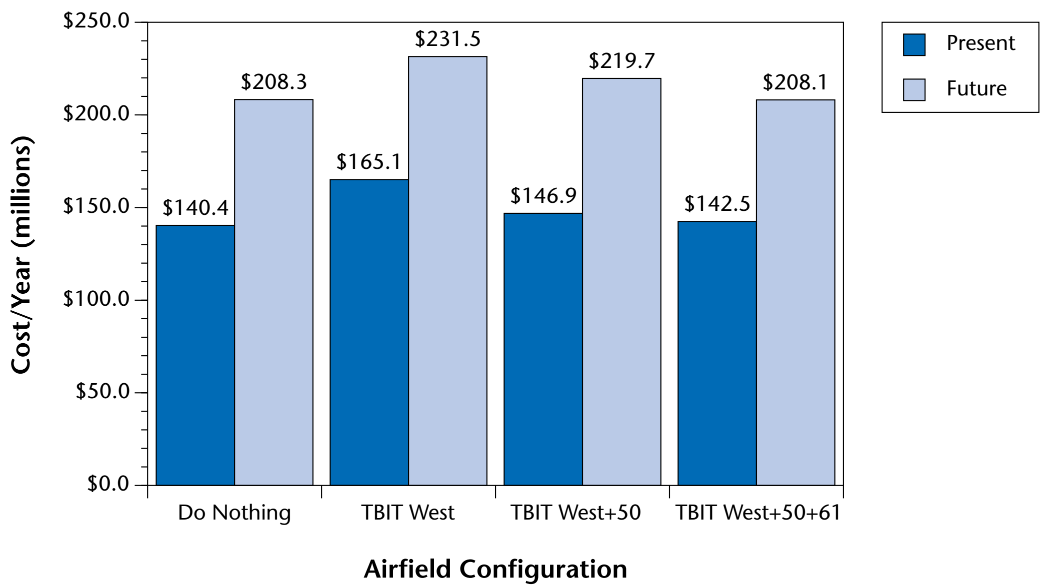
Figure 4 summarizes the increased airfield delay costs that would result from the addition of new gates on the west side of TBIT and the airfield delay costs associated with each alternative tested in this study. The following conclusions were reached based on these results.

- The addition of new gates on the west side of TBIT would cause unacceptable airfield delays due to the effects on aircraft movement between the north and south runway complexes. The use of Taxiway 75 as a high-speed taxiway would only slightly reduce the delay.
- The delays caused by the addition of gates on the west side of TBIT could be mitigated by an extensive and costly construction program to move the functions of Taxiways 48 and 49 to the west.
- Airfield delays will continue to grow at LAX due to the increased operations. The construction of new high-speed crossover taxiways will only mitigate the impacts of the new gates at TBIT, not the effects of growth in operations.

The ACE Action Team recommended three areas of further study:

- A full cost-benefit analysis to determine if the benefits of the added gates at TBIT justify the costs to provide the new taxiway system.
- Further study to determine if the landside and terminal capacity of TBIT can accommodate additional terminal gate capacity.
- Preliminary results indicate that the extension of Taxiway T to the west could facilitate airfield traffic movement in the future. Additional detailed study is recommended.

Figure 4. Present and Future Annual Delay Costs — Do Nothing and TBIT West Alternative with Taxiway K East and Slow Taxiway 75 (Future has WESTPAC Remote Terminals)



Appendix A Participants

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Appendix B Data Inputs and Assumptions

Airfield Gates

Figure 5 associates all of the airlines with specific gates at Los Angeles International Airport (LAX Gate). The table also indicates the corresponding gate number that was used in the Airport Machine simulation model itself (APM Gate).

Figure 6 depicts the LAX gate numbers and locations at the individual terminals for Terminals 1 through 8. Figure 7 shows the gate numbers and locations for TBIT East and the gate locations for TBIT West. Figure 8 shows the WESTPAC Remote Terminals (west of Taxiway 75). The WESTPAC Terminal gates were included in the Future case in the study.

At the baseline level of operations, aircraft were assigned to specific gates according to the field data collected. The new gates on the west side of TBIT were randomly assigned for both the baseline and future cases. For the future activity level, fifteen additional gates were available at the WESTPAC remote parking terminals. All WESTPAC gates were shared by domestic and international aircraft. The domestic aircraft in the future demand schedule that were not in the baseline demand schedule were randomly assigned to gates both at the existing terminals and at WESTPAC. The additional international aircraft in the future demand schedule were assigned on a random basis both to the west-side gates at TBIT and to WESTPAC remote parking terminals.

Figure 5. Airline Gate Assignments

LAX GATE*	APM GATE*	AIRLINES
1	1	AWE
2	2	USA
3A	3	AWE
3B	4	AWE
4A	5	USA
4B	6	USA
5	7	SWA
6	8	SWA,USA
7	9	SWA
8	10	USA
9	11	SWA
10	12	USA
11	13	SWA,USA
12A	14	SWJ,USA
12B	15	SWA,USA
13	16	SWJ,SWA
14	17	SWJ,USA
21	18	AVA,NWA,ACA
22	19	NWA,HAL
23	20	NWA,ACA,HAL
24	21	NWA
25	22	NWA
26	23	NWA
27	24	VIR,NWA,ACA
28	25	VSP,NWA,ACA
30	26	ASA
31A	27	ASA
31B	28	ASA
32	29	ASA
33	30	TWA
34	31	TWA
35	32	TWA
36	33	
37A	34	TWA
37B	35	NWA
38	36	NWA
39	37	
42A	38	AAL
42B	39	AAL
43	40	AAL
44	41	AAL,WWM
45	42	WWM
46	43	AAL
47	44	AAL
48	45	AAL
49A	46	AAL
49B	47	AAL
AM EAGLE	48	WWM
AM EAGLE	49	WWM
AM EAGLE	50	WWM
AM EAGLE	51	WWM
AM EAGLE	52	WWM

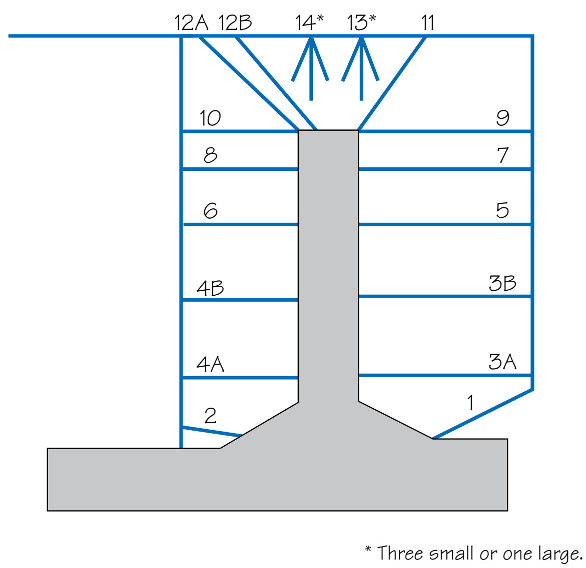
LAX GATE*	APM GATE*	AIRLINES
AM EAGLE	53	WWM
AM EAGLE	54	WWM
AM EAGLE	55	WWM
AM EAGLE	56	WWM
AM EAGLE	57	WWM
AM EAGLE	58	WWM
50B	59	DAL
51A	60	DAL
51B	61	DAL
52A	62	DAL
52B	63	DAL
53A	64	DAL
53B	65	DAL
54A	66	DAL
54B	67	DAL
55A	68	DAL
55B	69	DAL
56	70	DAL
57A	71	DAL
57B	72	
58	73	DAL
59	74	DAL
60	75	COA
61	76	DAL
62	77	COA
63	78	DAL
64	79	COA
A	80	SKW
66	81	COA
B	82	SKW
D	83	SKW
68A	84	COA
68B	85	COA
69A	86	DAL
69B	87	COA,DAL
70A	88	UAL
70B	89	UAL
71A	90	SDU,MSE
71B	91	UAL
72A	92	UAL
72B	93	UAL
73A	94	UAL
73B	95	UAL
74	96	UAL
75	97	UAL
77	98	UAL
76	99	UAL
80	100	UAL
81	101	UAL
82	102	UAL
83	103	UAL
84	104	UAL

LAX GATE*	APM GATE*	AIRLINES	LAX GATE*	APM GATE*	AIRLINES
R3	105	GIA,LRC,MXA,SIA	120	141	ARR,AMX,BAW
R4	106	AMX			CDN,VRG,UAL
R2	107	CDN,MXA	121	142	ASA,CES,PAL,SAS,SER,TAI
R1	108	ARG,MXA,VRG	122	143	ASA,KLM,MXA,QFA
WEST PAD	109		123A	144	ASA,AMX,CDN,
WEST PAD	110				MXA,SER,TAI
WEST PAD	111		123B	145	AMX,MXA,SER
WEST PAD	112		(32F)	146	DAC,EWW,FLC,ROA
WEST PAD	113		(26F)	147	AWI,CFS,MDC,
WEST PAD	114				MRA,PRC
WEST PAD	115		(16F)	148	EIA,FDX,FLC,
MGM	116	MGM			LNW,ROA
ALH	117	ALH	(11F)	149	ABX,AMF,CKF,
ALH	118	ALH			FLC,ROA,VST
ALH	119	ALH	(J6)	150	ZAN
UED	120	UED	(J6)	151	UPS
GRA	121	GRA,PQA	(K61)	152	
101	122	ANZ,CAL,CDN,EUA,	(4C)	153	NCA,SJN
		LRC,MAS,MXA	31C	154	ASA
102	123	AMX,CDN,DLH,JAL,	71A	155	SDU
		KAL,SWR,TAI	71A	156	SDU
103	124	ANZ,KAL,LRC,	71A	157	SDU
		MXA,THA.UAL	71B	158	SDU
104	125	AFR,ANA,ANZ,	71B	159	SDU
		CPA,MXA,UAL	71B	160	SDU
105	126	AMX,ANZ,AZA,	A	161	SKW
		JAL,QFA,VRG	A	162	SKW
106	127	XX1	A	163	SKW
TBIT W 107	128		B	164	SKW
TBIT W 108	129		B	165	SKW
TBIT W 109	130		B	166	SKW
TBIT W 110	131		B	167	SKW
TBIT W 111	132		C	168	SKW
TBIT W 112	133		C	169	SKW
TBIT W 113	134		C	170	SKW
TBIT W 114	135		D	171	SKW
TBIT W 115	136		I	172	WWM
TBIT W 116	137		I	173	WWM
TBIT W 117	138		14	174	SWJ
TBIT W 118	139		14	175	SWJ
119	140	ASA,AMX,CDN,GUG,	13	176	SWJ
		KAL,MXA,QFA,SER	13	177	SWJ

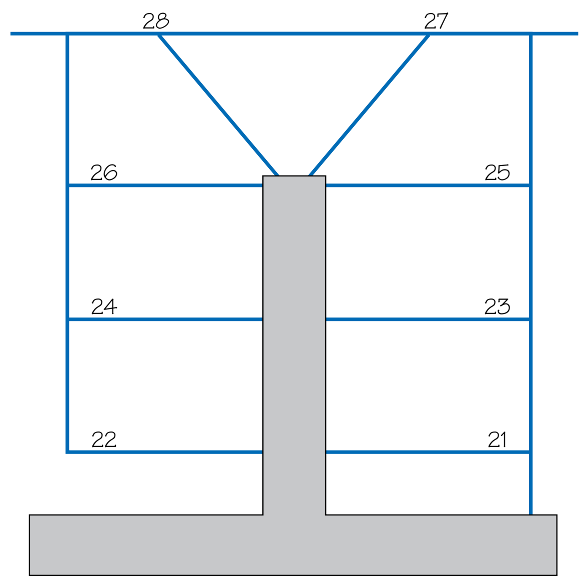
* Note: LAX Gate — Specific gate designations at Los Angeles International Airport.
APM Gate — Gate number used in the Airport Machine simulation model.

Figure 6. Gate Numbers — Terminals 1 Through 8

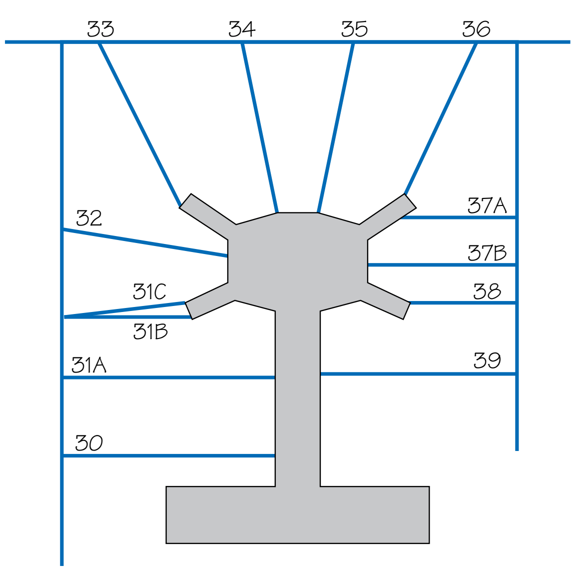
Terminal 1



Terminal 2



Terminal 3



Terminal 4

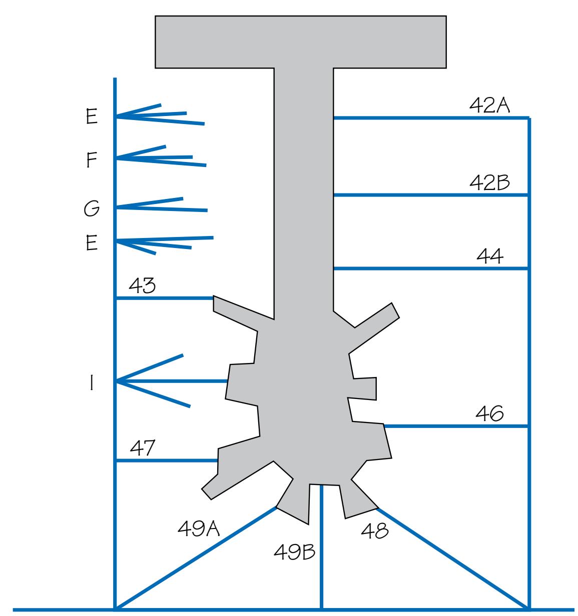
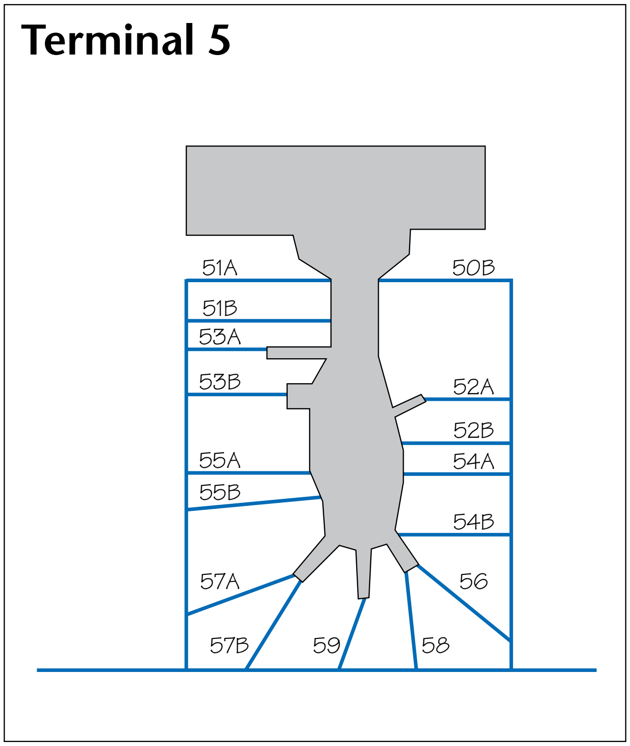
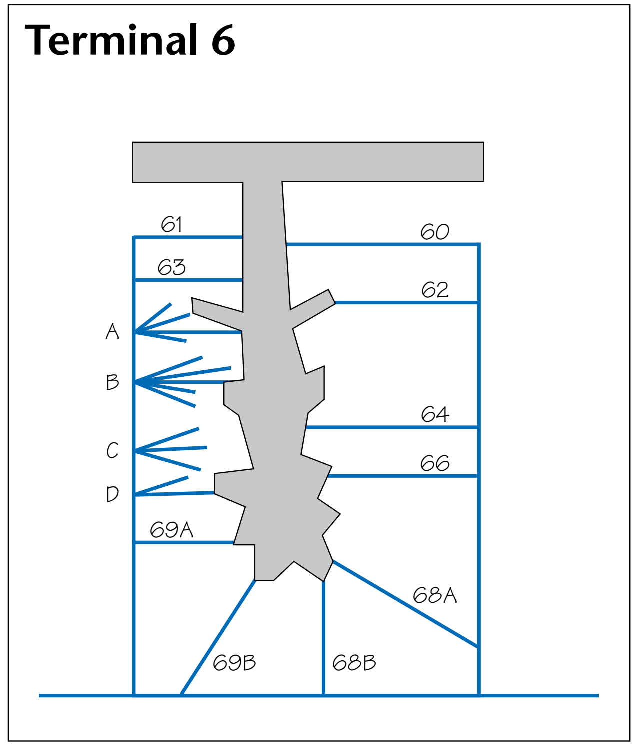
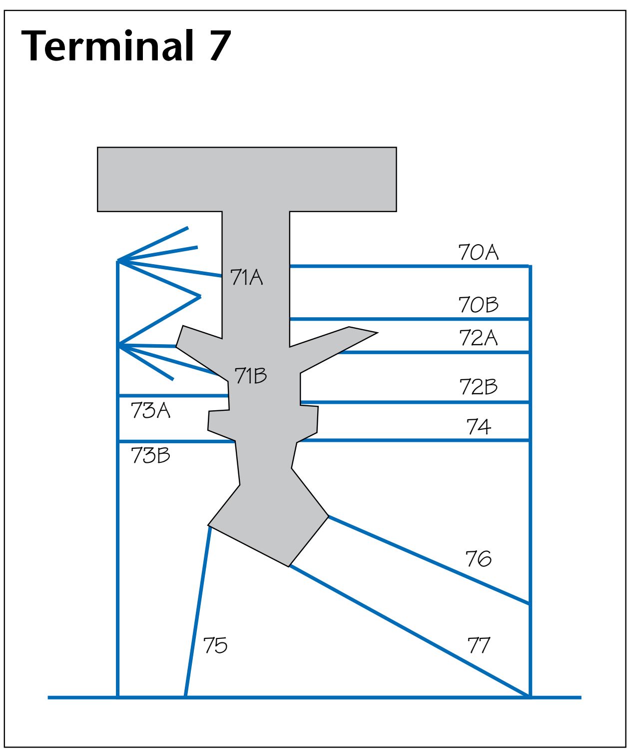


Figure 6. Gate Numbers — Terminals 1 Through 8 (continued)







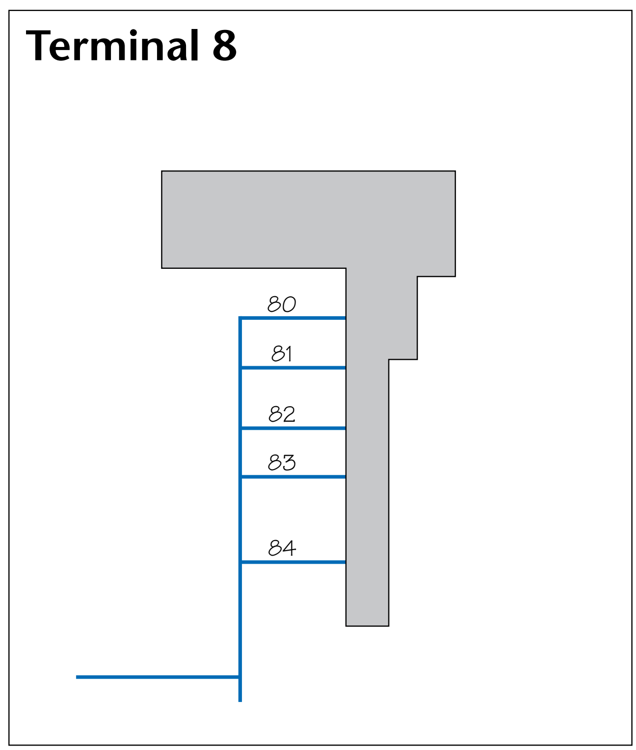
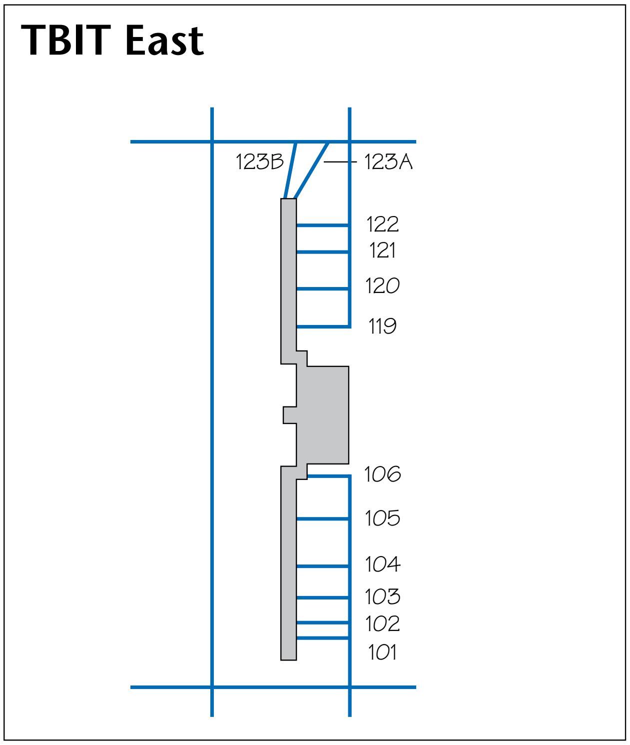


Figure 7. Gate Numbers TBIT East and TBIT West Gates



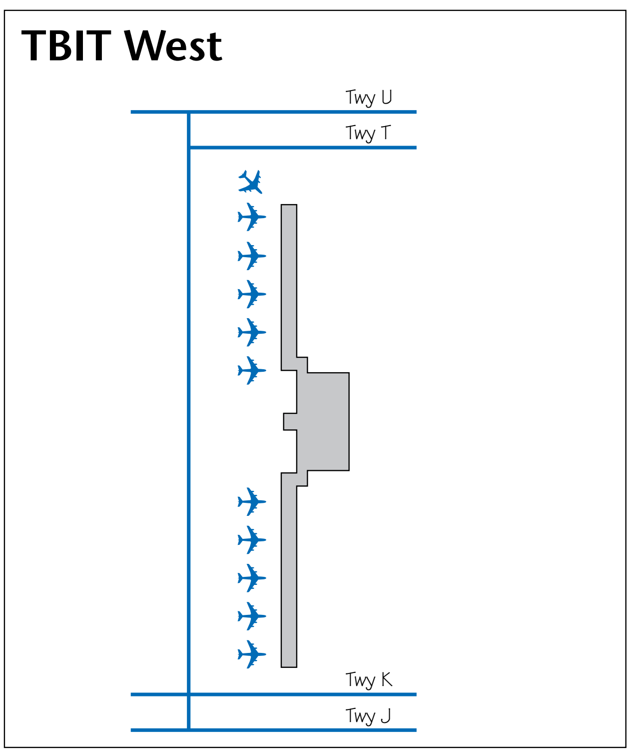
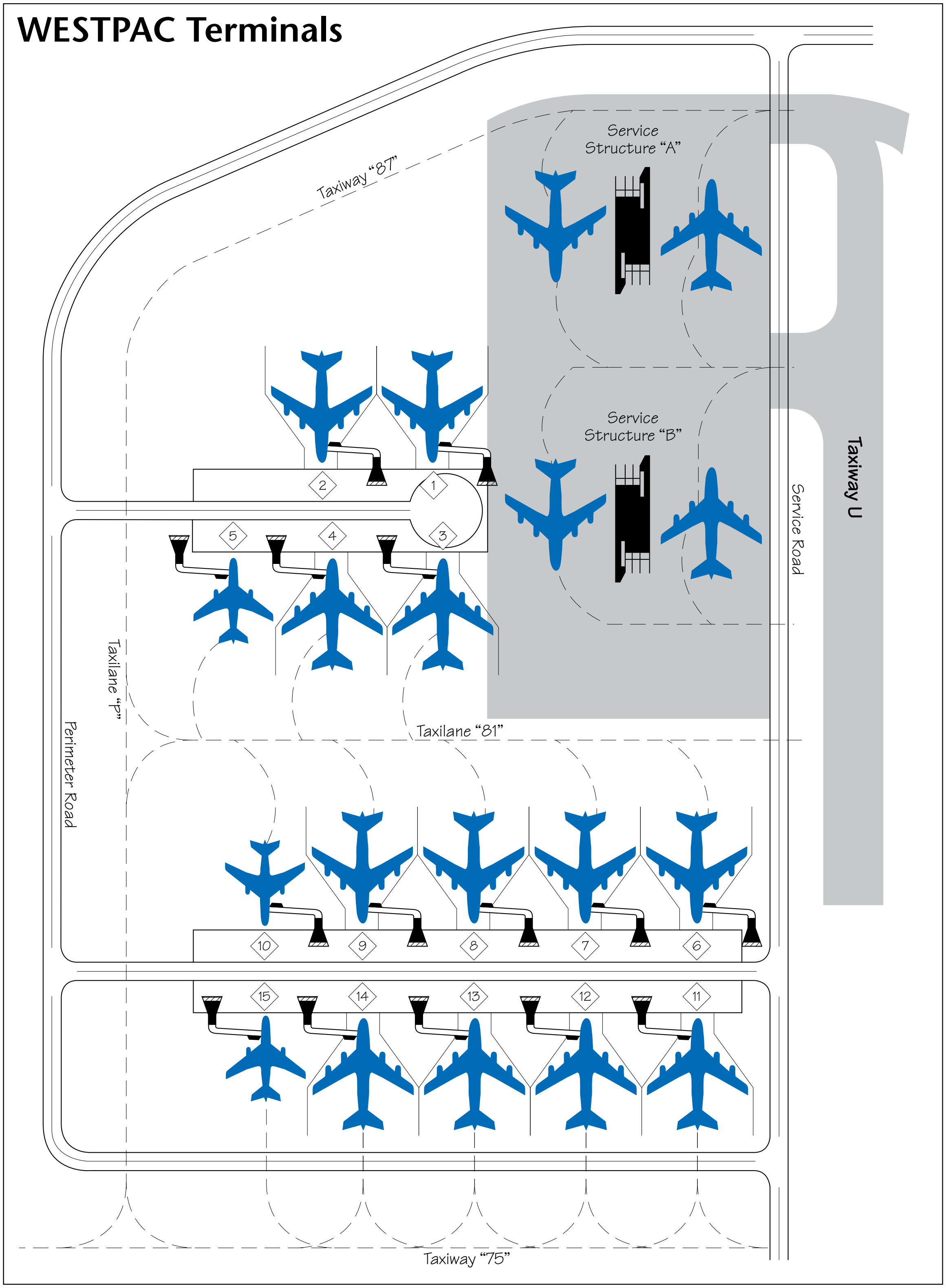


Figure 8. WESTPAC Remote Terminal Gates — Future Case



Taxiway Directions and Speeds

Outside taxiways, such as Taxiways J and U, are one-way in front of gates toward the departure end of the runways. Taxiway U is two-way west of Taxiway 48. When the addition of Taxiway T west of Taxiway 48 was examined in the study, Taxiway U was one-way eastward, and Taxiway T was one-way westward. Taxiway J is always one-way towards the east. Taxiways T and K are both two-way taxiways in front of the gate areas. West of the gate area, Taxiway K is one-way towards the west.

Figures 9 and 10 show the cross-complex taxiway directions and taxiway speeds.

Figure 9. Cross-Complex Taxiway Direction

Taxiway	Do Nothing	TBIT West	TBIT West + Twy 50	TBIT West + Twy 61
48	N			
49	S	S*	S*	S*
75		N*	S*	N&S*
50			N	N
61				S

* Note: Designates taxilanes. Otherwise, used as high-speed taxiways.
N = North, S = South.

Figure 10. Taxiway Speed (in knots)

Aircraft Class	Normal Taxiway All East-West Taxiways and Short Connectors	Taxilanes Between Terminals and Taxiways 75* and 49**	High-Speed Taxiways Taxiways 48, 49**, 50, 61, 75*	Towing Speeds
International Widebody	16	8	18	1/2 of taxiway speeds to the left
Domestic Widebody	16	8	18	
International Narrow Body	18	9	20	
Domestic Narrow Body	18	9	20	
Commuters	23	12	25	
Twin-Engine Prop	18	9	20	

Notes: * Taxiway 75 is examined both as a high-speed taxiway and as a taxilane.
** Taxiway 49 is a high-speed taxiway in the Do Nothing case and a taxilane when TBIT West is added.

Aircraft Operations

Figure 11 depicts the aircraft separations incorporated in the study. Note that only a west flow and VFR conditions were used.

Figure 11. Aircraft Separations

Arrival to Arrival Separations (time in seconds)						
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	**Class 6**
Class 1	3.86	3.86	4.67	4.67	4.67	5.49
Class 2	3.86	3.86	4.67	4.67	4.67	5.49
Class 3	3.06	3.06	2.97	2.97	2.97	3.69
Class 4	3.06	3.06	2.97	2.97	2.97	3.69
Class 5	3.06	3.06	2.97	2.97	2.97	3.69
Class 6	3.06	3.06	2.97	2.97	2.97	2.89

Departure to Departure Separations (time in seconds)						
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	**Class 6**
Class 1	90	90	120	120	120	120
Class 2	60	60	120	120	120	120
Class 3	60	60	60	60	60	50
Class 4	60	60	60	60	60	50
Class 5	60	60	60	60	60	50
Class 6	50	50	45	45	45	35

Departure to Arrival Separations (distance in nautical miles)						
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	**Class 6**
Class 1	1.51	1.51	1.41	1.41	1.41	1.30
Class 2	1.51	1.51	1.41	1.41	1.41	1.30
Class 3	1.51	1.51	1.41	1.41	1.41	1.30
Class 4	1.51	1.51	1.41	1.41	1.41	1.30
Class 5	1.51	1.51	1.41	1.41	1.41	1.30
Class 6	1.32	1.32	1.23	1.23	1.23	1.13

Figure 12. Runway Exit Probabilities

Runway 25L												
Exit	3G&H	8G&H	20G	24F&G	32H	28H	36H	42G&H	45G&H	47G&H	53G&H	63G&H
Class 1	0	0	0	0	0	2	42	84	97	97	100	100
Class 2	0	0	0	0	0	2	42	84	97	97	100	100
Class 3	0	0	0	0	4	4	17	77	94	98	100	100
Class 4	0	0	0	0	4	4	17	77	94	98	100	100
Class 5	0	0	0	4	18	18	54	90	100	100	0	0
Class 6	0	0	0	4	18	18	54	90	100	100	0	0

Runway 25R												
Exit	3J	8H&J	24H&J	28J	30J	32J	36J	42J	45H&J	47H&J	53H&J	63J
Class 1	0	0	0	0	0	0	30	50	70	80	80	100
Class 2	0	0	0	0	0	0	30	50	70	80	80	100
Class 3	0	0	0	0	10	0	43	70	88	100	100	100
Class 4	0	0	0	0	10	0	43	70	88	100	100	100
Class 5	0	0	0	0	20	0	60	80	92	100	100	100
Class 6	0	17	0	0	35	0	64	94	100	100	100	100

Runway 24L											
Exit	33U	36U	45U	47U	52U	61U	65U	75U	80U	85U	87U
Class 1	0	0	0	0	0	8	37	100	100	100	100
Class 2	0	0	0	0	0	8	37	100	100	100	100
Class 3	0	0	0	8	0	24	72	96	100	100	100
Class 4	0	0	0	8	0	24	72	96	100	100	100
Class 5	0	0	0	8	0	30	90	100	100	100	100
Class 6	0	0	0	16	0	33	100	100	100	100	100

Runway 24R						
Exit	33V	47V	52V	65V	75V	80V
Class 1	0	0	0	8	89	100
Class 2	0	0	0	8	89	100
Class 3	0	0	14	40	97	100
Class 4	0	0	14	40	97	100
Class 5	0	1	30	94	100	100
Class 6	0	5	83	100	100	0

Figure 13. Other Aircraft Assumptions

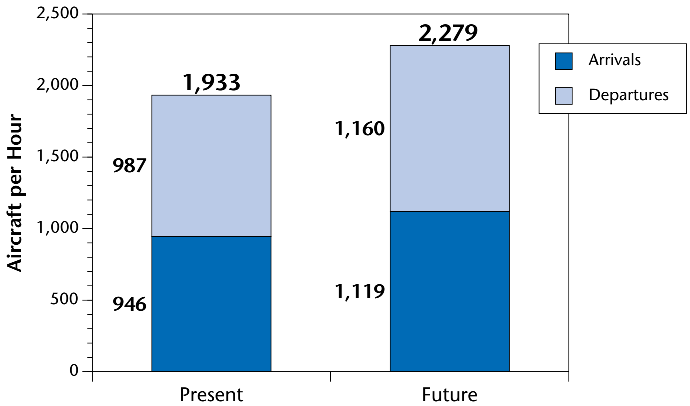
	Approach Path	Approach Speed	Landing Speed	Runway Occupancy Time	Pushback Time	Gate Service Time			
						Thru Flight	Turn Around	Arrive Only	Depart Only
Class 1	6 nm	140 kts	130 kts	60 sec	540 sec	1.7 hr	1.2 hr	0.5 hr	0.5 hr
Class 2	6 nm	140 kts	130 kts	60 sec	180 sec	1.0 hr	1.2 hr	0.5 hr	0.5 hr
Class 3	6 nm	130 kts	120 kts	52 sec	420 sec	0.8 hr	1.0 hr	0.4 hr	0.4 hr
Class 4	6 nm	130 kts	120 kts	52 sec	180 sec	0.8 hr	1.0 hr	0.4 hr	0.4 hr
Class 5	6 nm	130 kts	120 kts	52 sec	60 sec	0.6 hr	0.8 hr	0.3 hr	0.3 hr
Class 6	3 nm	120 kts	110 kts	52 sec	60 sec	0.6 hr	0.8 hr	0.3 hr	0.3 hr

Figure 14. Runway Use — Present and Future Schedule

Runways	Present		Future	
	Arrivals/Day	Departures/Day	Arrivals/Day	Departures/Day
24R	376	93	429	93
24L	72	332	76	386
25R	86	438	92	556
25L	412	124	522	125
Total	946	987	1,119	1,160

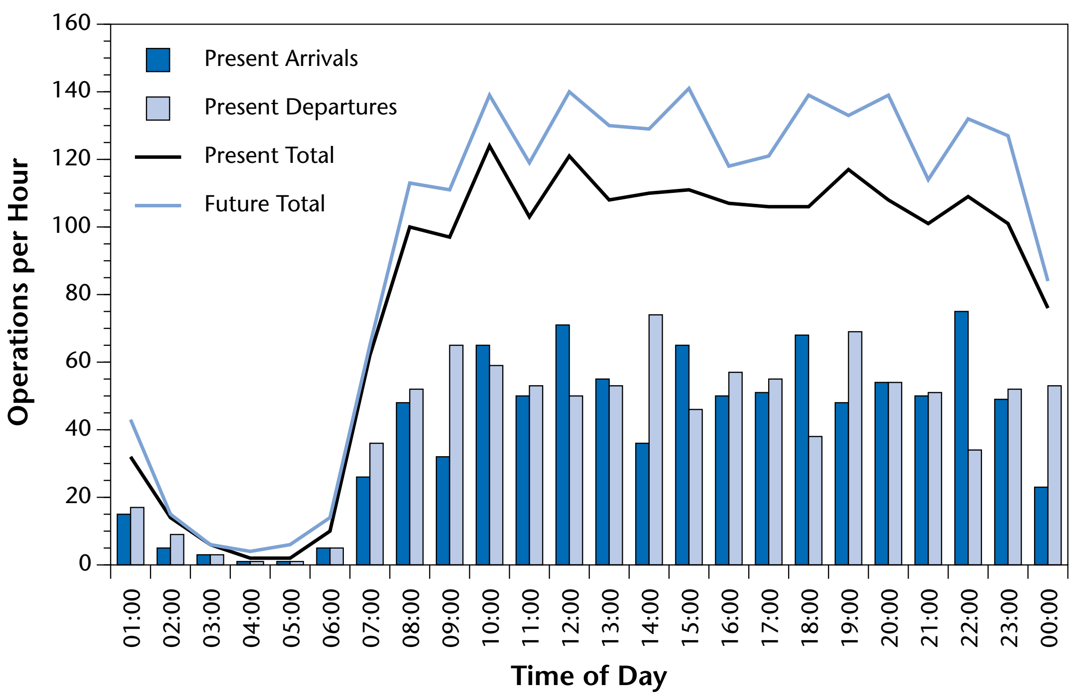
Figure 15 illustrates the daily total and peak-hour demand levels for the present and future cases. Figure 16 shows the hourly profile of daily demand for the present level of activity and includes a curve that depicts the profile of daily operations for the future demand level. The present demand schedule depicts actual field data collected on December 18, 1992. The data collected provided the airline, aircraft class and type, runway used, gate used, and the scheduled time. The future demand schedule was based on a forecast total of daily operations provided by the Los Angeles Department of Airports. The future level of operations represents about an 18 percent increase over the baseline level and approximates LAX at a level of 65 million annual passengers (MAP). The daily operations total was divided into the same proportions as the baseline demand schedule by hour, aircraft class and type, and airline.

Figure 15. Airfield Demand Levels



Aircraft Operations	24-Hour Day	Peak Hour
Present	1,933	124
Future	2,279	141

Figure 16. Profile of Daily Demand — Hourly Distribution



Appendix C Computer Model and Methodology

The Los Angeles International Airport ACE Action Team studied the effects of various operational and airfield facility improvements proposed to accommodate the addition of 11 new gates on the west side of TBIT. The options were evaluated considering the anticipated increase in demand. The analysis was performed using computer modeling techniques. A brief description of the model and the methodology employed follows.

The Airport Machine

The Airport Machine is a PC-based, interactive model with animated graphics display that is used to evaluate proposed changes to airfield and terminal configurations, schedules, and aircraft movement patterns. It is an excellent tool for taxiway and gate analysis. Output from the model provides extensive data on delays and travel times in aircraft movements.

Methodology

Model simulations included present and future air traffic control procedures, various airfield improvements, and traffic demands for different times. To assess the benefits of proposed airfield improvements, the FAA used only a west flow runway configuration derived from present and projected airport layouts. The projected implementation time for air traffic control procedures and system improvements determined the aircraft separations used for VFR weather simulations. Data inputs for the model and for model calibration were derived from field data collected at LAX.

For the delay analysis, agency specialists developed traffic demands based on the Automated Radar Terminal System (ARTS), historical data, field observations, and various forecasts. Aircraft volume, mix and peaking characteristics were developed for each demand level (present and future). The estimated annual delays for the proposed improvement options were calculated from the experimental results. These estimates took into account the runway configuration, weather, and demand based on historical data.

Appendix D List of Abbreviations

ACE	Airport Capacity Enhancement
APM	Airport Machine — computer simulation model
ARTS	Automated Radar Terminal System
ATC	Air Traffic Control
ATCT	Airport Traffic Control Tower
CAT	Category — of instrument landing system
FAA	Federal Aviation Administration
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LAX	Los Angeles International Airport
MAP	Million Annual Passengers
MI	Miles
NM	Nautical Miles
RFP	Request for Proposal
TBIT	Tom Bradley International Terminal
TRACON	Terminal Radar Approach Control
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
WESTPAC	West End Remote Terminal Gates

Notes:

Notes:

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